Space Weather Technical Forecast

Issued on Tuesday, 21 November 2023 at 01:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Increasing Chance of R1. Risk of G1, peaking Tuesday 21 Nov, due to coronal hole and high speed steam influences.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was moderate, with a single M1.27 flare at 20/0903 UTC, emanating from AR3492. There are currently nine sunspot groups on the disc, all of which are in the eastern solar hemisphere.

AR3490 has been separated into two regions, with the leading portion numbered AR3492, which produced the aforementioned M1.27 flare. AR3489 continues to show magnetic complexity, with the presence of a delta spot. Further proliferation and movement within its central portion. All other regions on the disc remain small and relatively stable. Numerous filament and prominence eruptions were apparent on coronagraph imagery in the period, although the vast majority appear to be far-sided or else emanated from the limbs. No Earth-directed CMEs observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, have been in a slow-ambient regime, with solar wind speeds ranging between 350km/s, declining to around 300km/s in the past 24 hours, with hints of a very weak transient feature early in the period, probably from the CME which left the Sun on the 16 Nov. The solar density, however, as shown a steady rise, from background to moderate levels, peaking 29 ppcc at 20/2224 UTC. The IMF followed a similar trend, rising through the period, peaking at moderate levels, 14nT at 20/1003 UTC. The north-south component (Bz) remained weak, varying between +7/-5nT. Finally, the phi angle was mainly negative (towards the Sun), but re-orientated to positive (away from the Sun) by the end of the period. The net result of the above solar wind parameters was for Quiet geomagnetic activity throughout the period.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels.

GOES16 high energy (greater than 2MeV) electron flux ranged from Normal Background to Moderate levels, with a peak of 449pfu at 20/1610UTC. The associated 24-hour fluence has declined slightly and remains below the Active threshold (1e8 integrated pfu). The fluence observation at 21/0001UTC was 7.18e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of M-class flares from current eastern solar horizon sunspot regions, perhaps rising slightly as a result of a further arrival over the eastern limb.

Solar Wind / Geomagnetic Activity: Solar winds are currently at background levels, although are likely to increase to slightly elevated or elevated levels, between 450-500km/s due to the arrival of a high speed stream from CH73/+ on Day 1 (21 Nov), possibly lasting into Day 2 (22

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Nov) before waning and declining to background levels by Days 3 and 4 (23-24 Nov). Geomagnetic activity is currently Quiet, before the arrival of a coronal hole fast wind, with activity becoming Unsettled to Active, with a Slight Chance of a G1/Minor Storm on Day 1 (21 Nov), possibly into Day 2 (22 Nov), becoming mostly Quiet by Day 4 (24 Nov).

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is expected to remain at Background levels.

GOES16 high energy electron flux is expected to continue to peak at Moderate levels at first, before the arrival of a fast wind from CH73 until midweek, which should suppress the electrons in the short-term, with perhaps a steady rise by the end of the period, as HSS/CH influences begin to wane. The associated 24-hour electron fluence will most likely remain below the Active (1e8 integrated pfu) level in this four-day period, but with a probable increasing trend into the tail end of the UTC working week.

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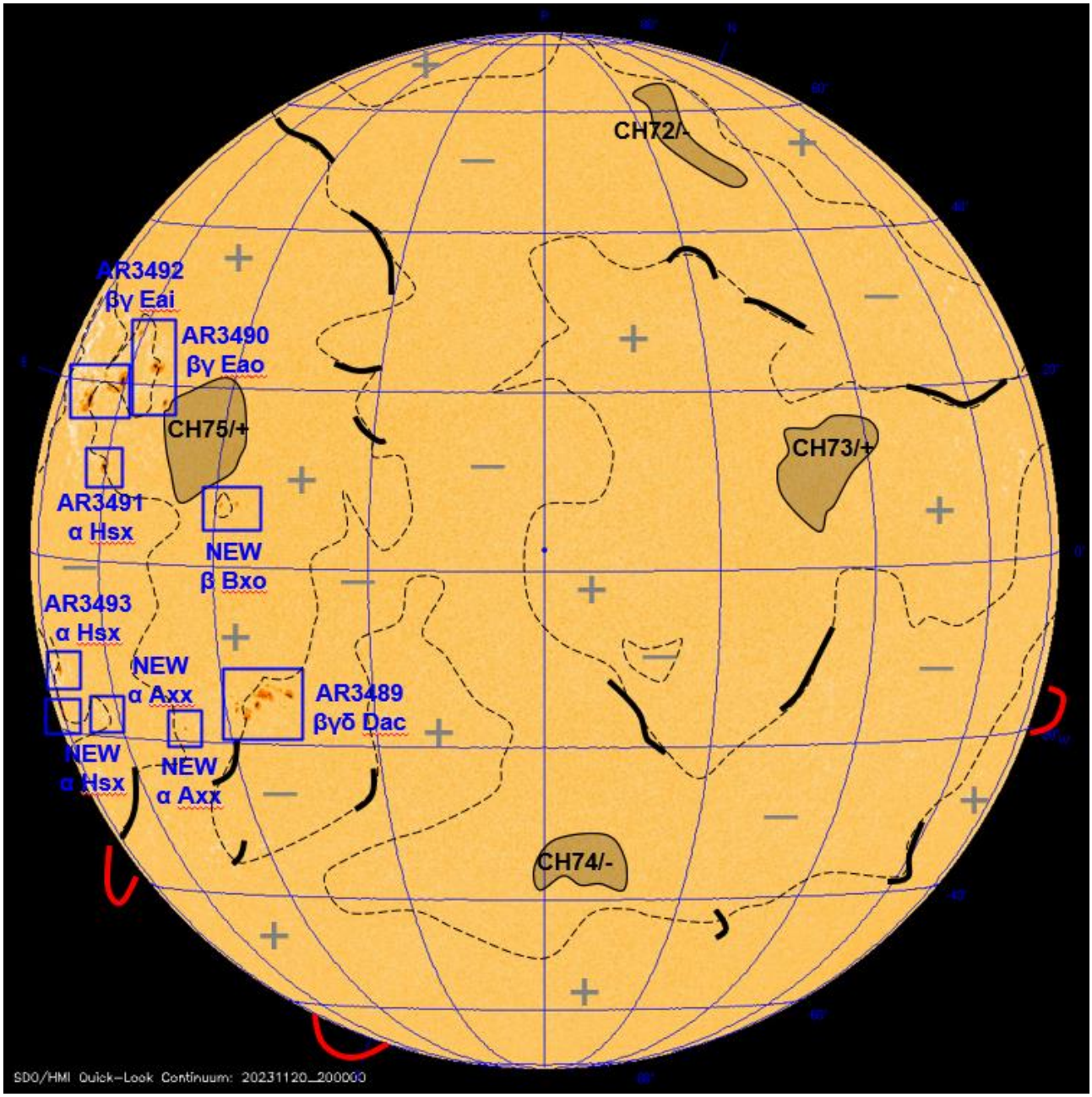
Figure 1. Solar Analysis Valid 20/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
No Earth-directed CMEs currently feature in the forecast.

The coronal hole-based forecast now comprises of CH73/+, a clear feature currently lying close to the solar equator narrowly in the western hemisphere which is likely to affect Earth on Day 1 (21 Nov) and Day 2 (22 Nov). On the previous rotation, this feature was at a similar longitude and produced winds of around 450-500 km/s. This feature is now visually darker and more pronounced on AIA211, and a faster emanating wind is therefore inferred of around 500km/s.
In terms of other potential sources of geomagnetic activity in the forecast that are not yet quantified in the percentages, much of the CME activity seen on available coronagraph imagery over the past 24 hours has been tied to the eastern solar horizon. This is likely to play an increasing role in the risk of geomagnetic activity through the period should activity persist. In addition to this, there are a number of filaments on the disc which have the potential to disrupt and lift-off, perhaps producing Earth-directed CMEs, although there is nothing to imply this is imminent or in progress at the time of writing.

Overall, the geomagnetic forecast comprises of mostly Quiet conditions at first, increasing to Unsettled or Active, during Day 1 (21 Nov) with the arrival of a fast wind from CH73/+, lingering into Day 2 (22 Nov), with a Slight Chance of a G1/Minor Storm. Reducing to mostly Quiet or Unsettled by Days 3 and 4 (23-24 Nov).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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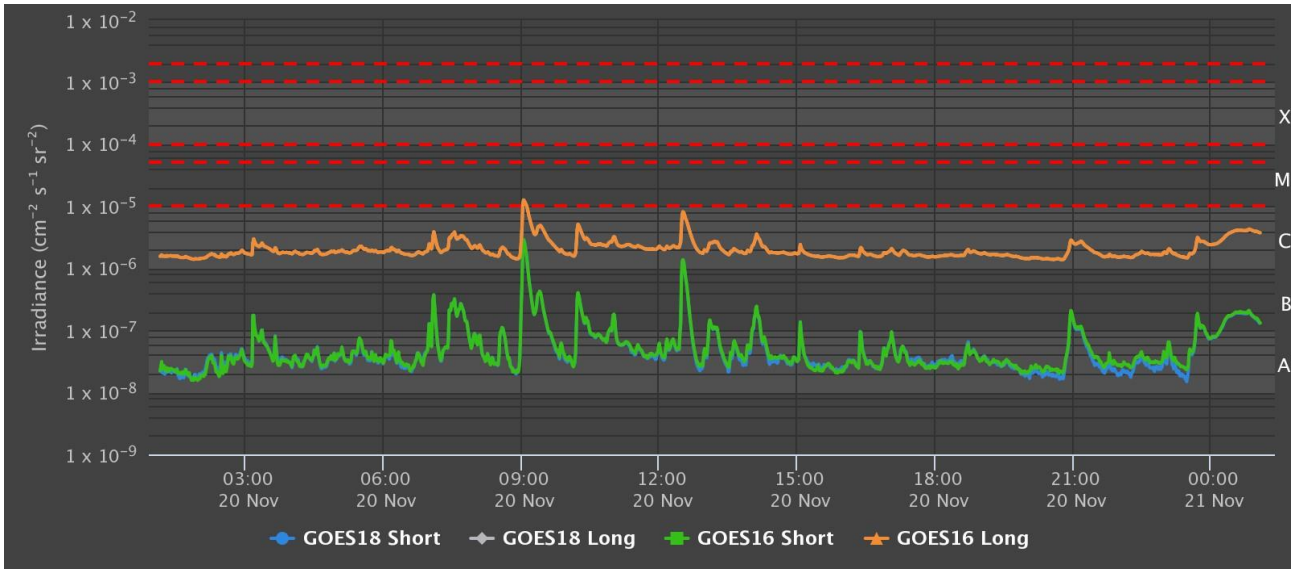
Radio Blackouts - X-Ray Flares:
There are currently nine sunspot groups on the disc, all of which are in the eastern solar hemisphere. AR3489, in the southeast, showed further proliferation and movement in its central spots, now with a delta spot.

Meanwhile, the complexity of sunspot regions in the northeast have now been separated into two regions. AR3490 is now the leading region, with the newly numbered AR3492 following close on behind, although a more accurate analysis of this region will be made as it continues to rotate away from the limb. These two regions combined give a large and complex area in the northeast quadrant. All other spots are small and simple at present, with a NEW small region emerging behind AR3489 and two NEW spots emerging on the southeast limb, with one numbered AR3493 (Hsx/Alpha).

All considered, there is a rising Chance of M-class flares given the complex eastern solar horizon and the potential for still more regions arriving here in the first half of the UTC working week. X-class flares are now also considered a daily Slight Chance given the potential in AR3490 and AR3492 in particular.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: GOES16 X-ray flares



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at Background levels.

The arrival of one of potentially several large and complex regions over the eastern solar horizon over the coming days has resulted in an above background risk of a S1/Minor Solar Radiation Storm. This risk remains nominal until any significant groups approach the western solar hemisphere. There are no significant off-going regions offering any diminishing contribution to this risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux levels are expected to continue in a similar vein to the UTC weekend at first, having likely reached a steady state in varying between Normal Background and Moderate flux levels. Following the arrival of the 16/0100UTC weak CME, flux levels at GEO may be briefly suppressed, with this effect probably sustained by any fast wind from CH73 arriving Day 1 (21 Nov), before a late-week (UTC) increase to a peak Chance of Active fluence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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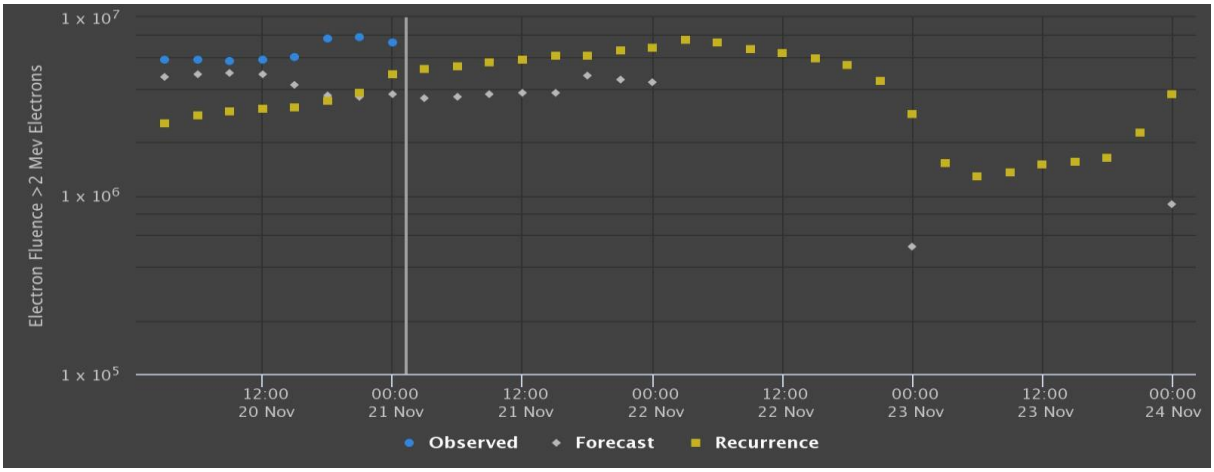
Figure 4: REFM model showing electron fluence.



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